PULVERIZED COAL FURNACES

By Emmet Smith, '28

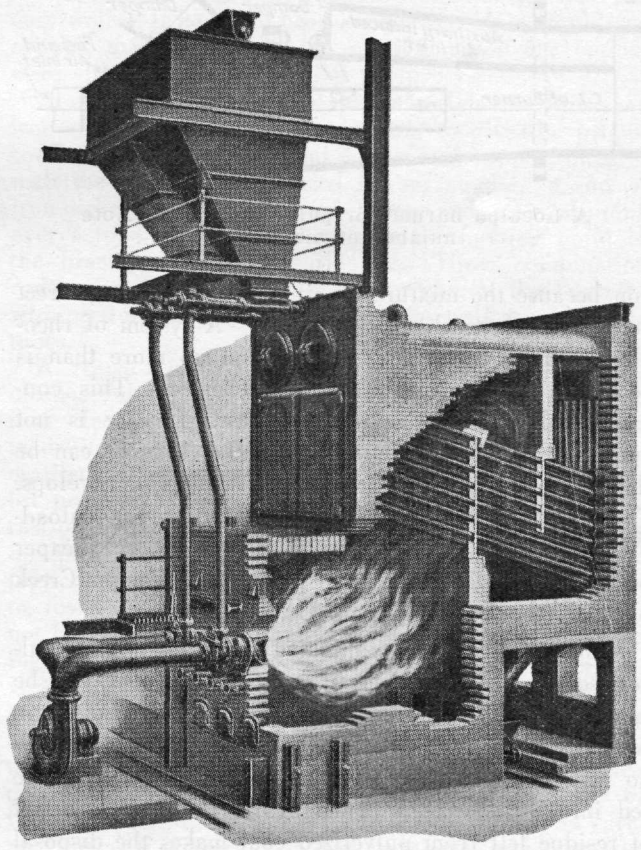
USING pulverized coal as a fuel was first conceived in 1818, but at that time the economical generation of steam was not considered an important problem. Fuel was plentiful and cheap, steam was used in comparatively small amounts, and other types of furnaces were good enough. When manufacturing companies began to need more steam and to install larger boilers, furnaces were improved and automatic stokers were introduced. These stokers eliminated the laborious task of firing by hand, cut down the operating expenses as well as saved coal. With the continued increase of the need of larger boilers, attention again turned to the pulverized coal furnace. The first practical use of this furnace was made in 1916 in the cement industry, but the chemical conduct of coal was not thoroughly understood until experiments were made to determine just how coal would act in the pulverized form. With the knowledge that was obtained from these experiments, a furnace was designed in 1919 to burn pulverized coal and a year later this furnace was installed and worked efficiently.

The process of preparing pulverized coal is the most important factor in operating a furnace to the best advantage. The coal is taken from the railroad cars, conveyed to a crusher which reduces it to lumps about the size of an egg, and then dried thoroughly. It then goes to the pulverizers which grind the lumps to a fine powder much like soot. In this form, the coal is again dried and fed into the pipes which convey the coal dust to the furnaces by means of a forced air draft. Most other types of furnaces grind the coal to small lumps and feed it into the furnaces with automatic stokers. The preferable types of furnaces are the ones that will deliver the best service most economically.

Due to the large amount of apparatus necessary for a pulverized coal furnace, it would not be financially advisable to change boilers already equipped with other types of furnaces. The initial cost and installation of all large furnaces are expensive propositions and very few companies can afford to make this change unless their equipment has passed the stage of usefulness. The pulverized coal furnace is only practical where large amounts of steam are used twenty-four hours a day, such as in power plants and water works.

Since pulverized coal furnaces have been developed to a point that makes their usage practical, an argument has been raised as to which furnace is the best. Companies that have used pulverized coal furnaces believe that more heat per ton of coal can be obtained from pulverized coal and that the temperature can be varied to satisfy the load and in that way save coal. They also find that by using superheated steam, fewer boilers are necessary and on the whole the maintenance and operating costs are reduced.

A good furnace must economically utilize fuel, and pulverized coal furnaces have a greater efficiency than other types of furnaces. This is because coal in the pulverized form burns more readily. It is evident that if the surface of the coal is increased, more air comes into contact with the particles and combustion takes place more rapidly. Through experiments, coal in lumps has been found to burn more slowly because a layer of ash covers the interior part to form a protecttive blanket which retards complete combustion, while coal dust has been found to ignite with explosive violence and practically all the particle is burned. Plants operating pulverized coal furnaces find that the residue left in the form of ashes is only six to eight per cent of the amount of coal burned. When coal is burned in lumps, foreign material fuses together to form clinkers which clog the furnace and cause trouble. The residue of pulverized coal is composed of the same material which is not combustible, but instead of fusing together it is left in a fine dust which is easily disposed of. In the pulverized coal furnaces, the heat can be better directed, for the coal is fed into the furnace through jets and the flame looks very much like a gas flame except in color. The jets can be adjusted to play the hottest part of the flame



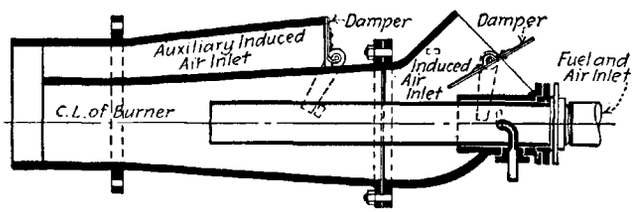
Babcock & Wilcox horizontal type boiler equipped for firing with pulverized coal.

directly on the boiler and in this way the sides of the furnace do not get so hot as in other furnaces. The ceramic engineers have been trying for some time to make a brick that will stand a high temperature for an indefinite length of time, but as yet they have not been entirely successful.

The efficient operation of pulverized coal furnaces has been proven in the case of the Cleveland Electric Illuminating Co. This company has fifty-four auto-

matic stoked furnaces which burned 5,000 tons of coal daily when running at full capacity. A few years ago eight pulverized coal furnaces were installed. These eight furnaces generate enough steam to run the entire plant on a light load and many of the other furnaces have been cold for some time. Other companies, such as the Milwaukee Electric Railway and Light Co. and the Detroit Edison Co., installed pulverized coal furnaces and the results proved so favorable that the Detroit Edison Co. is now installing nothing but pulverized coal furnaces in their new power plant at Detroit, Mich.

The operating and maintenance costs of pulverized coal furnaces are reduced because the appartus is of simple construction. The only extra piece of machinery that is required is a device to pulverize and dry the coal. These pulverizers are small units and are easy to operate, for one man can take care of about twelve pulverizers without difficulty. The biggest saving is in the fact that there are no grates to repair or renew, no new or heavy motors required to operate the stokers. The operation of the furnace itself requires less attention because the mixture of air and coal in the correct proportions is mechanically done. A system of rheostats regulate the feed of air so that no more than is necessary to burn the coal is preheated. This controlling device also indicates when a furnace is not operating properly and that particular furnace can be shut off and repaired before any serious trouble develops. The maintenance and operating costs from the unloading hoppers to the disposal of the ashes are cheaper per ton of coal as proved in tests at the Conner Creek plant of the Detroit Edison Co.



A Loculpo burner for pulverized coal. Note number of air inlets.

Many expenses are eliminated with the use of pulverized coal and even cheaper grades of coal can be used. In a furnace using lump coal, the drafts are regulated at the judgment of the fireman and there is no way of determining the correct amount of air to be fed into the furnace. Then again, the small amount of residue left from pulverized coal makes the disposal of the ashes almost negligible. In the pulverized coal furnace, when the cost of pulverizing the coal is considered, one is apt to draw the conclusion that this cost would exceed the amount of waste in other furnaces, but this is not true. Pulverizing the coal is not an expensive operation and this expenditure is overbalanced by the cost of operating and repairing stokers in other furnaces. When a stoker breaks, the furnace must be shut down; but when a pulveriver breaks, only that piece of machinery is shut down. The rest of the apparattus can cotinue to operate.

Much coal is found in the sand along the Susquehanna River. This coal can be dredged and used as well as many other inferior grades of coal. Sometimes coal that will not burn in stokers will burn efficiently in the powdered form.

The way a pulverized coal furnace is operated makes the regulation of the temperature easy. This is one of the biggest advantages of the furnace. Coal is saved because when a furnace is started, it heats quickly to generate the desired amount of steam. With lump coal this is expensive, for about forty tons of coal are required to raise a cold furnace to 150 per cent rating. With pulverized coal, when the load is decreased, the feed of coal can be decreased and in that way no coal is wasted in banking fires. When something unforeseen comes up and a large amount of steam is needed in a hurry, a pulverized coal furnace will meet the necessity much more quickly than another furnace. In case of boiler trouble, a furnace that will cool quickly will enable the necessary repairs to be made and resume operation again, sooner than the furnace of the usual type. Besides time being lost, money is lost and the service of the plant curtailed by a slow heating furnace.

The pulverized coal furnace is still in the experimental stage. Of the many companies in the United States operating pulverized coal furnaces, it is interesting to note that no two companies operate their furnaces just alike. The grade of coal used and the shape of the furnace have a direct bearing on the way a furnace must be run. In some cases where a poor grade of coal is used, the residue seems to be at the right temperature to fuse with the walls of the furnace. This makes a heavy scale on the bricks and in time may cause trouble. In some furnaces the walls are water cooled to prevent this scale and it has worked effectively, but a special kind of fire brick is being tried to eliminate this trouble completely.

Some kinds of coal require no drying before entering the furnace, while other grades must be treated twice or the coal dust will clog in the burners. The Narragansett Electric Co. is building a new plant at Providence. R. I. Pulverized coal furnaces are being installed and the whole boiler equipment is in a separate building. A careful record will be kept of all the coal that is burned, the amount of ash, and the efficiency of the furnaces. The Combustion Engineering Co. is installing the furnace equipment and the four boilers are expected to deliver 385 lbs. of steam at 200 deg. and generate 4,000 H.P. each. These are some of the most modern pulverized coal furnaces being built and it will be interesting to watch the outcome of the tests.

The A. S. M. E. held a meeting in Cleveland last January to discuss the possibilities of this type of furnace and the popular opinion was that many features could still be improved. A company installing pulverized coal furnaces must expect to experiment until the maximum efficiency is reached. Even at this time the pulverized coal furnace has many desirable features that other types of furnaces do not possess.